directed into the Atchafalaya River system would provide additional wetland building potential in an area currently in a growth phase.

The last core strategy in Subprovince 3 builds upon the previous strategy. The Atchafalaya River, in combination with the Wax Lake Outlet Channel (WLOC), is currently in the building phase of delta development. This river system also provides freshwater and sediment to large portions of the Terrebonne estuary's wetlands. The proactive management of those available riverine resources would greatly increase the current productivity of the estuarine system.

In the Chenier Plain, which is encompassed by Subprovince 4, there are no excess riverine resources available to promote land building and to control salinities in the estuarine system. As a result, the core strategy for this subprovince is the control of estuarine salinities through the management of existing hydrology and geomorphologic features. Because the coastal landscape is continually subsiding relative to the level of the Gulf of Mexico, the physical exclusion of gulf salinities and management of natural rainfall and runoff inputs to the system will provide the best opportunities to maintain system stability.

4.0 DEVELOP AND EVALUATE RESTORATION PROJECTS AND FEATURES (PHASE III)

Using the core strategies for coastal restoration as a guide, the PDT undertook the development of restoration features for each of the subprovinces. The features that were developed also needed to be able to be combined to achieve the established planning scales. Four public meetings were held throughout coastal Louisiana in February 2003. At these meetings, input from the public was solicited regarding the development of restoration features to address the restoration strategies. The PDT assembled into sub-groups to develop restoration features to fit the strategic requirements of each subprovince. This phase of plan formulation identified a range of practical and accepted restoration features along with their characteristics. The PDT succeeded in developing and quantifying an initial suite of discreet possible solutions for coastwide restoration.

In this phase, each feature was developed independently with preliminary costs and land building, or land loss modifying, potential being estimated based on experience and insight gained through the execution of the CWPPRA program, along with the best available information and professional judgment. The ten years of effort in project development and design under the CWPPRA program, along with design work completed under other Federal and State programs, provided an extensive base of design information to build on. Detailed documentation of the design assumptions, feature level of detail, and development of the cost estimates is available at the Engineering Division of the New Orleans District office of the U.S. Army Corps of Engineers (USACE). The result of this phase was a "tool box" of restorations features for each subprovince. This phase of plan formulation also provided insight into the types of tools and metrics that would be required in the plan evaluation process.

During this phase, 166 potential restoration features were developed. The intent of this effort was to provide an initial identification of the most effective frameworks for meeting the overarching study objectives, in concert with key strategies in each subprovince. The features are specific projects, such as freshwater reintroduction (diversion), sediment diversion, outfall management, hydrologic restoration, interior shoreline protection, barrier island and barrier headland restoration, and marsh creation and restoration. A brief description of the various types of features is provided below:

- *Freshwater Reintroduction (Diversion) Projects:* Freshwater reintroduction (diversion) projects restore deteriorated wetland areas with the nourishment of freshwater, sediment, and nutrients. Freshwater helps to relieve areas that have suffered from the effects of saltwater intrusion, while sediment and nutrients promote the growth of new marsh in areas that are subsiding.
- *Sediment Diversion Projects:* Sediment diversions allow nutrient- and sediment-rich freshwater to flow into surrounding wetlands. This is similar to freshwater diversion, but maximizes sediment input.
- *Dedicated Dredging and Beneficial Use, Marsh Creation and Restoration Projects:* Dedicated dredging marsh restoration projects utilize sediment that is dredged for maintenance of navigation channels and access canals, or material that may be dredged specifically for marsh restoration. The sediment is placed in a deteriorated wetland or open water area at a specific elevation so that desired marsh plants will colonize and grow to form new marsh.
- *Salinity Control:* Salinity control projects provide for the construction of new structures or the operation of existing structures for the purpose of controlling saltwater intrusion.
- *Hydrologic Restoration Projects:* Hydrologic restoration projects address problems associated with artificially altered hydrology by reverting deteriorated drainage patterns toward more natural drainage patterns.
    - Structure Modification Projects
    - Hydrologic Modification Projects
- *Land Acquisition:* In instances where land is deemed valuable to the successful structure and function of restoration projects, it may be in the best interest of the public and the environment to acquire this land via easements or fee purchase.
- *Barrier Island, Barrier Headland, and Interior Shoreline Protection and Restoration Projects:* Barrier island restoration projects are designed to protect and restore Louisiana's barrier islands that protect interior areas and provide important stopover habitat for many migrant avian species. Shoreline protection projects are designed to decrease or halt shoreline erosion. Some actions are applied directly to the eroding shoreline, while others are placed in the adjacent open water to decrease a wave's energy before it hits the shoreline. This could promote the buildup of sediment and includes planting of vegetation, as necessary.

In each subprovince, the composition of the techniques represented in the features was guided, but not limited, by the critical restoration strategies identified for that area. The range of the magnitude of output was geared to be commensurate with the identified ecological scales within each subprovince. **Table E-2** provides the makeup of restoration features by subprovince.

Table E-2.
Types of Restoration Features by Subprovince.

Feature Type	Subprovince 1	Subprovince 2	Subprovince 3	Subprovince 4
Freshwater Reintroduction (Diversion)	21	30	1	
Sediment Diversion	21	18	1	
Dedicated Dredging and Beneficial Use / Marsh Creation and Restoration	12	4	1	1
Salinity Control	1		2	16
Structure Modification (Hydrologic Restoration)	4	1		
Hydrologic Modification (Hydrologic Restoration)	1		12	4
Land Acquisition	1			
Barrier Island, Barrier Headland, and Interior Shoreline Protection and Restoration	1	1	10	2

The initial efforts in developing the restoration features involved identifying potential restoration footprints within a subprovince and developing scaleable designs to achieve various levels of success. As an example, a footprint for a large sediment-reintroduction feature would be delineated by the team and the total potential area for restoration within it identified using a Geographic Information System (GIS). With a point of introduction and estimated total-material-volume-required provided, designers would then produce max-mean-min designs and sediment reintroduction requirements. These levels were typically 70 percent and 35 percent reduction in open water area or a minimum mean introduction of flow. The use of three sizes wherever possible in developing features allowed flexibility in scaling the features when assembling alternative frameworks. For smaller reintroduction features focused on system management, three mean flows would be prescribed for an area based on the experience and judgment of the team.

This technique worked well for features that involved the reintroduction or addition of water or sediment to a system. For strategies where management of *in situ* conditions was required or in areas where the input of additional resources was not an option, the development of features focused on management. The development of these features was typically controlled by existing geomorphology and the level of natural system inputs. The combination of features developed for the management of Atchafalaya River water moving through the Terrebonne Basin of Subprovince 3 is an example of this. These features are dependent on the existing channel and ridge network, which produces both the current hydrology and the potential for modifying it. Another example would be the combination of features to manage salinity in the Chenier Plain. Due to the morphology of the Chenier Plain, this strategic objective can be accomplished with a few major features at the perimeter of the basin or a number of smaller features in the interior of the basin.

Once the team had delineated the potential restoration footprints for each feature, designers began developing scaleable designs and cost estimates. In addition, for any features introducing additional resources, the designers provided relative levels of freshwater introduction and land building for each level. The team developing the features was then able to make preliminary estimates of the ecological output (in acres created) that each feature would produce. In addition to any available land-building estimates, the teams considered current land-loss rates within each footprint and estimated the degree that this rate might be reduced by the considered feature. This allowed the team to estimate acres protected by each feature as well. The team also made initial assessments of the positive, negative, or neutral fit of the features to the major goals and objectives established for the study. This positive, negative, or neutral assessment was also made for each feature against a broad range of significant resources. These assessments were used to identify and screen any features that would not support the environmental goals of the study.

5.0 DEVELOP AND EVALUATE ALTERNATIVES – SELECT A FINAL ARRAY OF COASTWIDE FRAMEWORKS (PHASE IV)

Due to the number of possible restoration features and scales, as well as the number of possible combinations, the effort of developing all possible framework outputs was unmanageable within even a standard study timeframe. The assembly of alternative frameworks using study criteria, best available information, and professional judgment was adopted as an acceptable method to establish model scenarios. The evaluation of these frameworks developed across the range of identified output scales that would then provide an evaluation framework from which relative effectiveness and completeness of frameworks could be gauged.

Utilizing the ecological criteria established in the initial phase of the study, these teams combined the restoration features into alternative frameworks capable of achieving the various identified restoration scales. The alternative development teams utilized the broader goals, principles, and guidelines to formulate criteria for creating similar alternative groups of features across the ranges of restoration scales in each subprovince. Applying the ecological criteria and the output projection established for each restoration feature, each alternative development team developed several significantly different frameworks for each desired subprovince output level. An initial framework for formulation goal was an array of ten alternative frameworks (including No Action) for each subprovince.

The PDT selectively used existing hydrodynamic and ecological models, as well as agency and academic expertise, on a limited number of alternative frameworks in each subprovince to produce a base of information. "Desktop" hydrologic and ecological models were developed based on the numeric modeling output. The application of these desktop models to the remaining alternative frameworks was undertaken by the PDT members. From the desktop model output for each alternative, based on the combined effects of the individual